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STATE OF MONTANA
RESOURCE DAMAGE PROGRAM

COMPENSABLE NATURAL RESOURCE DAMAGE DETERMINATION - UPPER CLARK FORK RIVER NPL SITES

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COMPENSABLE NATURAL RESOURCE DAMAGE DETERMINATION FOR THE UPPER CLARK FORK RIVER NPL SITES

STATE OF MONTANA
NATURAL RESOURCE DAMAGE PROGRAM

Prepared by:

RCG/Hagler Bailly
P.O. Drawer O
Boulder, Colorado 80306-1906
(303) 449-5515

Robert D. Rowe
Edward R. Morey
William D. Schulze
William S. Breffle

DECEMBER 1993

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LIST OF ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CV	Contingent Valuation
CVM	Contingent Valuation Method
DOI	Department of the Interior
EPA	Environmental Protection Agency
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
NRD	Natural Resource Damage
NRDA	Natural Resource Damage Assessment
NRDP	Natural Resource Damage Program
OMB	Office of Management and Budget
WTA	Willingness to Accept
WTP	Willingness to Pay

1.0 INTRODUCTION AND SUMMARY OF RESULTS

1.1 INTRODUCTION

In this report we determine the past, interim, and residual compensable natural resource damages for the Clark Fork National Priorities List (NPL) sites based on the applications of a recreation demand model and the contingent valuation method.

A damage determination is undertaken to "establish the amount of money to be sought in compensation for injury to natural resources resulting from a discharge of oil or release of a hazardous substance." [43 CFR § 11.80 (b)]. Damages include two components:

> The cost of restoration, rehabilitation, replacement, and/or acquisition of the equivalent of the injured natural resources and the services those resources provide, ***plus*** the compensable value of the services lost to the public for the time period from the discharge or release until the attainment of the restoration, rehabilitation, replacement, and/or acquisition of the equivalent of the resources and their services to baseline. [Proposed 43 CFR § 11.80 (b)]. (Emphasis added.)

Natural resource damage (NRD) restoration costs are those costs necessary to restore natural resources and their services to *baseline conditions* (those conditions that would exist if the release of hazardous substances had not occurred) and are in addition to Environmental Protection Agency (EPA) remedies. NRD restoration costs are not addressed in this report but will be addressed in a separate report.

Compensable value includes "the value of lost public uses of the services provided by the injured resources, plus lost nonuse values such as option, existence, and bequest values." [Proposed 43 CFR § 11.83 (c)(1)]. *Use values* refer to the values of activities by individuals and family members that are affected, now and in the future, by natural resource injuries and include impacts to recreation, indirect use, and commercial activities. *Nonuse values* (also called *passive use*) refer to the values individuals hold to protect or enhance resources not related to their own use and include bequest values to ensure the availability of the resources for use by others now and in the future, and existence values to protect the resource apart from well-identified uses of the resource.[1] Compensable value is added to restoration costs.

---

[1] These terms are discussed further by the Department of the Interior (DOI) in its natural resource damage assessment regulations (56 Fed. Reg. at 19759-60). Some authors define the terms slightly differently, but these differences have little substantive effect because damages are the total of all use and nonuse values.

Estimates of compensable value are used to measure damages before, during, and after cleanup activities. In this report we use the term "cleanup activities" to refer to either the EPA remedy or NRD restoration activities, or a combination of the two that partially or completely return (or restore) injured natural resources and their service flows to baseline conditions. We consider three levels of cleanup activities beyond what has occurred in the past:

> *Complete cleanup* of the sites, or a combination of the EPA remedy and the NRD restoration that returns natural resources and their service flows to *baseline* conditions.
>
> *Partial cleanup* of the sites in a manner consistent with or exceeding remedial actions the EPA will likely require under the Superfund Program, but which will not completely return injured natural resources and their service flows to baseline conditions.
>
> *No additional cleanup* of the sites. In this case, no remedy or restoration is undertaken now or in the foreseeable future.

Regardless of the cleanup scenario, it will take some time from injuries to natural resources and their service flows to be mitigated. For this analysis, we conservatively assume that any partial or complete cleanup at the sites will reduce injuries and damages over a 20-year period.

In this report we group damages into past, interim, and residual damages as defined below (see also Section 2.1):

> *Past damages* are those damages that occurred from the onset of injury up to the present (1994 in this analysis). For this report we consider past damages back to 1981, although injuries and damages have occurred since the late 1800s.
>
> *Interim damages* are those damages that occur between the time that the EPA remedy and NRD restoration activities begin (assumed to begin in January 1994) and the time that the restoration of the natural resources and their service flows from the activities is fully realized (assumed to be in January 2014).
>
> *Residual damages* are those damages that occur after the EPA remedy and the NRD restoration activities are finished and the benefits from these activities are fully realized. These damages occur because cleanup activities do not restore natural resources and their service flows to baseline conditions, and these damages continue indefinitely.

1.2 NATURAL RESOURCE INJURIES AT THE CLARK FORK NPL SITES

Natural resource injuries are described in the injury assessment reports. For this summary, we consider injuries in three groups:

1. Aquatic resources and riparian habitat (Lipton *et al.*, 1993a)
2. Groundwater resources (Montana NRDP, 1993)
3. Upland soils, vegetation, wildlife, and wildlife habitat (Lipton *et al.*, 1993b).

As identified in the injury assessment reports, injuries have existed in the past and are continuing today. In this report we assume that past injuries were at the same level as 1992/1993 injuries, the time period when the injury quantification was completed. However, evidence suggests that injuries were even more severe in prior years. Therefore, the damage estimates reported here understate past damages.

1.3 SUMMARY OF RESULTS

Compensable damages are computed in Section 3 and are summarized in Table 1. Throughout this report, damages are computed to a present value in January 1994 using 1993 dollars, and using a 7 percent real discount rate as identified in the regulations ([43 CFR § 11.84 (e)(2)] and OMB, 1992).

Compensable past damages for 1981 through 1993 are $217 million if paid in 1994. If no additional cleanup is undertaken, the present value in 1994 of residual damages is $166 million. If complete cleanup completely restores natural resources and service flows continuously over 20 years, the present value in 1994 of the interim damages during the cleanup is over $48 million. If partial cleanup partially restores natural resources and service flows continually over 20 years, the present value in 1994 of interim and residual damages is over $80 million.

The time of payment for natural resource damages, and for cleanup of natural resources and their service flows, affects past, interim, and residual damages. For example, if past damages go unpaid for 2 additional years, additional interest on past damages would add another $31 million in damages. If complete cleanup takes 15 years, then interim damages decrease by about 15 percent. If complete cleanup takes 25 years, interim damages increase by about 10 percent (see Section 3.5).

Table 1
Summary of Damage Estimates
(millions of $ 1993, present value in 1994)

Damage Category	Time Period	Damages	Damages Included	Damage for Which No Estimates Are Available
Past Damages	1981 - 1993	$217	Montana resident use and nonuse values for all injured natural resources and natural resource service flows	Any and all nonresident use damages other than for fishing and nonfishing aquatic recreation
Interim Plus Residual Damages:			Nonresident use values for fishing and nonfishing aquatic recreation only	Any and all nonresident nonuse values
- Complete cleanup	1994 - 2013	$48		
- Partial cleanup	1994 - ongoing	$80		
- No additional cleanup	1994 - ongoing	$166		

The reported compensable damages understate total damages for the following reasons:

1. Damages are based on 1992/1993 levels of injuries. Injuries in prior years and decades were greater. Therefore, past damages are understated.
2. Injuries and damages occurred prior to 1981. Therefore, past damages are understated.
3. Interest will continue to accrue the longer past, interim, and residual damages are uncompensated, leading to a larger present value of past damages.
4. Under partial and complete cleanup activities, the partial or complete return of natural resources and their service flows to baseline conditions will take longer than 20 years to be realized. Therefore, the interim and residual damages are understated.
5. For nonresidents of Montana, use values, other than for aquatic and riparian recreation, and nonuse values are omitted. Therefore, past, interim, and residual damages are understated.

1.4 ORGANIZATION OF THIS REPORT

In Section 2.1 we further introduce the economic concepts used to estimate natural resource damages. In Section 2.2 we introduce the recreation demand model used to estimate recreation use damages for fishing and nonfishing recreation along the Clark Fork River and Silver Bow Creek, and we introduce the contingent valuation study used to estimate the total of use plus nonuse values held by Montana residents for all injured natural resources and natural resource service flows.

In Section 3 we apply the results of the recreation demand model and contingent valuation study to estimate past, interim, and residual damages. Detailed calculations are provided in Appendix A.

2.0 ECONOMIC CONCEPTS, METHODS, AND STUDIES

In this section we briefly introduce economic concepts and measures of value used in this assessment. We introduce valuation concepts and present a simple description of past, interim, and residual damages in Section 2.1. We then summarize the recreation valuation and contingent valuation studies and their results in Section 2.2.

2.1 CONCEPTS

2.1.1 Valuation Concepts

Injuries to natural resources affect the service flows that the resources provide to society. Reductions in service flows reduce the well-being of affected individuals through reductions in the ability to use the resource (use values), to bequeath the resource to others for use, or to preserve the resource in an unimpaired condition regardless of expected uses (nonuse values). Damage assessments place dollar values on impacts to well-being that result from natural resource injuries. A "fundamental economic principle is that individual judgments are the appropriate basis of value. That is, when a natural resource is injured, economists use individual values of that resource to determine the worth (value) of the injury" (DOI, 1987, pp. 1-2). Two monetary measures are routinely used:

> *Willingness to pay (WTP)*: How much an individual would be willing to pay to have avoided the injury. This serves as the measure of damage for incurring the injury.
>
> *Willingness to accept (WTA)*: How much compensation an individual would require to be as well off as before the injury occurred, or have to be paid to accept the injury.

The WTA measure may be appropriate if the affected individuals have a right to be compensated by polluters. WTA measures can be expected to exceed WTP measures, but measurement of WTA is more difficult than for WTP, especially in contingent valuation studies. For this reason, WTP measures are used in Natural Resource Damage Assessments (NRDAs), even though this may bias the damage determination downward. WTP measures are also consistent with choices made everyday in purchasing goods and services and through voting choices that entail costs to support changes in environmental quality and other public goods.

In the next section we review the recreation valuation study and contingent valuation study used to obtain estimates of WTP for the injuries to natural resources from releases of hazardous substances in the upper Clark Fork Basin. However, before turning to these studies, three additional issues associated with the valuation of natural resource damages are briefly addressed.

All Past, Present, and Future Damages Must be Included

The total of all use and nonuse values, aggregated across all affected individuals and across all affected years, is what is required for a complete damage assessment. An issue in determining past and interim damages concerns the inclusion of nonuse values. If cleanup activities are, with certainty, to be completed at some point in the future, current and future nonuse damages may be reduced because the natural resource will be available in the future. However, even with cleanup activities, nonuse damages have existed and continue to exist for at least three reasons:

1. If cleanup is not complete, then nonuse damages resulting from residual natural resource injuries continue to occur into perpetuity.

2. Even with a certain and complete cleanup of injured resources at some future date, there are ongoing nonuse damages from the lost bequest and existence values tied to resource injuries between the current year and the time the resource is restored. For example, assuming complete cleanup in 2014, nonuse damages occurred in 1981 (and all subsequent years up to 2014) because the resources would be injured for as many as 33 years.

3. Not until partial or complete cleanup occurs will there be certainty about what cleanup will accomplish, e.g., whether and when the natural resources and their service flows will be restored. This ties nonuse damages in the current year to uncertainty about the availability of the resources in the future. For example, until very recently there was little reason to anticipate significant cleanup of the upper Clark Fork Basin, and nonuse damages were because of the uncertainty of the availability of the resources in the future. Even now, with the expectation of EPA remedy to be imposed, there is still considerable uncertainty about exactly what cleanup will achieve.

Nonuse values are included in all past, interim, and residual damage determinations. The calculations include nonuse damages tied to residual injuries (item 1 above), and ongoing lost bequest and existence values before completion of cleanup efforts (item 2 above). The procedures to compute the past, interim, and residual nonuse values are presented in Appendix A. To be conservative, the calculations assume that there is certainty that the benefits from either partial or complete cleanup will be fully realized in 2014, and we exclude nonuse damages that result from uncertainty about the future availability of the natural resources and their service flows (item 3 above).

Discounting

In this analysis we follow the DOI regulations [43 CFR § 11.84 (e)(2)] and apply a 7 percent real discount rate using the most recent OMB-approved rate (OMB, 1992). A real discount rate is the interest rate net of the effects of inflation so that we are only dealing with real dollars (constant in 1993 dollars). The real discount rate is used to discount future damages to a present value. For example, $1 million in damages in 2004 has a present value in 1994 of $508,000. This means that $508,000 can be invested now at the stated real discount rate and will yield $1 million in 2004, which could be used to offset damages in 2004. Similarly, the real discount rate is used to assign interest to unpaid past damages. For example, $1 million in damages in 1984 has a present value in 1994 of $1.967 million. This means that if $1 million in damages had been paid in 1984 and had been invested at the real discount rate, then society would have assets worth $1.967 million. If damages are paid in the future (after 1994), the damage estimates reported here should be escalated to account for interest due using the real discount rate. Then, the damages should be escalated by the inflation rate between 1994 and the year of payment so that the real dollar value of compensation remains unchanged.

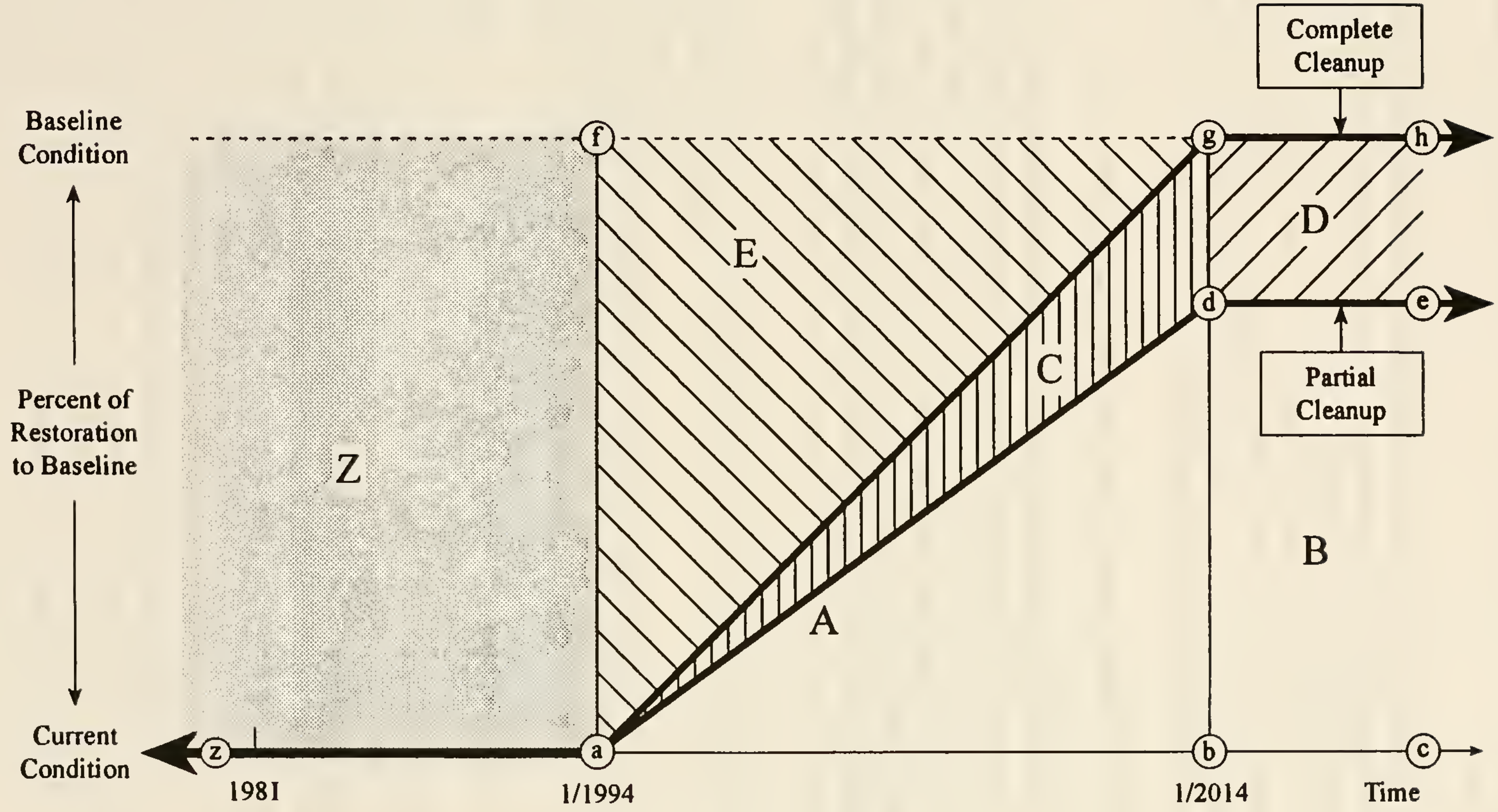
Values Through Time for Environmental Preservation

The damage determination is based on values held in 1992/1993, when the economics research was conducted. Economists have long held that benefits from the preservation of natural resources may rise over time because the supply of natural resources is fixed, and continued development of these resources (or reduced potential uses because of contamination) may increase their values because of increasing scarcity (Fisher *et al.*, 1972; Smith, 1972). Further, economic studies often show that values increase with real income. Because of the length of time projected for the return of natural resources and their service flows to baseline conditions, this issue is potentially significant. In this analysis we hold values constant through time, which results in a potential downward bias in the damage estimates.

2.1.2 Illustration of Past, Interim, and Residual Damages

We use Figure 1 to illustrate past, interim, and residual damages assuming cleanup activities take place between January 1994 and December 2013. The horizontal axis is time starting before 1981 and continuing past January 2014. The vertical axis measures the percent of restoration of natural resources and their service flows to baseline conditions that is achieved by cleanup activities through time. At the top of the vertical axis, natural resources and service flows are restored to 100 percent of baseline conditions. At the bottom of the vertical axis, injuries remain at 1992/1993 levels.

Figure 1
Past, Interim, and Residual Damages



Z = Past damages
E = Interim damages for complete cleanup over 20 years
C+E = Interim damages for partial cleanup over 20 years
D = Residual damages for partial cleanup over 20 years

The path of past cleanup is illustrated as the solid line (za). Future cleanup options are illustrated as follows:

- *Complete cleanup* results in full restoration of resources and service flows following line (agh). In January 2014, all resources and service flows are restored to baseline conditions.
- *Partial cleanup* results in partial restoration of resources and service flows following line (ade). In January 2014, not all resources and service flows are restored to baseline conditions.
- *No additional cleanup* is illustrated as line (abc).

We assume additional cleanup activities occur in a manner that linearly reduce damages over a 20-year time period. The partial or complete restoration of natural resources and natural resource service flows, and therefore the reduction in damages, may not exactly follow this pattern. For example, cleanup may proceed somewhat slower in early years, then faster in later years, or vice-versa. The effect on the damage determination of different assumptions about the time period of cleanup is addressed in Section 3.5. Past, interim, and residual damages are represented by various areas in Figure 1 as identified below.

Past Damages

Past damages are measured prior to 1994. Here, we measure damages only for 1981 through 1993 assuming injuries in this period are constant at a 1992/1993 level, the period for which the injury quantification was undertaken.

Area Z in Figure 1 represents the past damages.

Damages Avoided by Additional Cleanup Activities

Additional cleanup activities reduce damages through time.

Areas A+B represents the damages avoided by additional partial cleanup activities.

Areas A+B+C+D represent the damages avoided by additional complete cleanup activities.

Interim and Residual Damages

EPA remedy and NRD restoration activities will take many years to partially or completely return injured natural resources and their service flows to baseline conditions. During this period, interim damages occur. Once there is a complete return to baseline conditions, there are no residual damages. If cleanup activities do not completely return injured natural resources and their service flows to baseline conditions, there are residual damages. Interim and residual damages are illustrated as follows:

> Area E represents interim damages if complete cleanup is achieved.
>
> Areas C+E represent interim damages if partial cleanup is achieved.
>
> Area D represents residual damages if partial cleanup is achieved.

Compensable Damages

Compensable damages include past damages *plus* interim and residual future damages for the level of cleanup that is undertaken: Areas Z+C+D+E for partial cleanup, or Areas Z+E for complete cleanup.

The damages represented by the areas in Figure 1 are computed in Section 3 as multiples of the annual damages derived from the recreation valuation study and the contingent valuation method.

2.2 THE DAMAGE VALUATION STUDIES

2.2.1 Introduction

Two damage valuation studies were completed: a recreation valuation study and a contingent valuation method study. These studies are used to estimate different components of damages as illustrated in Table 2. The recreation valuation study is used to estimate use values for fishing and nonfishing recreation along the Clark Fork River and Silver Bow Creek for Montana residents and nonresidents. The recreation study does not calculate recreation use values for injuries at sites other than along the Clark Fork River and Silver Bow Creek (e.g., upland areas around Anaconda).

The contingent valuation study estimates all use and nonuse values for all natural resource and natural resource service flow impacts at the Clark Fork NPL sites, but only for Montana residents. The contingent valuation study does not provide damages for nonresidents of Montana.

Table 2
Correspondence Between Resource Groups, Service Flows, and Valuation Studies*

Resource Group	Service Flows	Values	Recreation Valuation Study		Contingent Valuation Study	
			Residents	Nonresidents	Residents	Nonresidents
Aquatic resources and riparian habitat	Fishing and nonfishing recreation	Use	X	X	X	
		Nonuse			X	
	All other service flows	Use			X	
		Nonuse			X	
Groundwater	All service flows	Use			X	
		Nonuse			X	
Upland soils, vegetation, wildlife, and wildlife habitat	All service flows	Use			X	
		Nonuse			X	

* "X" indicates the study provides a value for this combination of resource group, service flow, use motive, and population group.

The values for the two studies overlap for the Montana resident recreation damages along the Clark Fork River and Silver Bow Creek. This overlap is explicitly accounted for in the damage determination in Section 3.

For each of the two valuation studies we briefly introduce the study approach and summarize the computed damages. As noted in Section 2.1, the size of past, interim, and residual damages can be computed as multiples of annual damages based on 1992/1993 levels of injuries. Therefore, the estimates from the individual economic studies are converted to annual damage estimates in the discussions below.

2.2.2 The Recreation Valuation Study

The recreation valuation study estimates the use value damages for injuries to fishing and nonfishing recreation along the upper Clark Fork River and Silver Bow Creek (Morey *et al.*, 1993). Below, we separately summarize the fishing and nonfishing recreation damage assessments and how the results of these assessments are applied to compute past, interim, and residual damages.

Recreational Fishing Damages

Fish in the impacted area have been and continue to be exposed to hazardous substances. The result is smaller trout stocks than would exist under baseline conditions. For example, Silver Bow Creek, which extends approximately 30 river miles between Butte and Warm Springs Ponds, is unable to support any trout. Reductions in trout stocks reduce expected catch rates for anglers below what would occur under baseline conditions. Reduced catch rates cause damages in at least three ways: (1) anglers continue to take trips to these sites, but they enjoy the trips less because of reduced catch rates; (2) anglers substitute trips away from the injured sites to other, less-preferred sites that entail higher costs to visit or have lower catch rates than the impacted sites would have under baseline conditions; and (3) anglers forgo fishing trips that they would have desired to take to these sites under baseline conditions.

Fishing damages are estimated using a multiple-site recreation demand model, which is a *travel cost model.* Both the current and proposed regulations recognize using travel cost models as a best available procedure to estimate compensable use value damages [43 CFR § 11.83 (d)(3) and Proposed 43 CFR § 11.83 (c)(2)(ii)(B)]. Travel cost models are used to model how individuals would change their trip-taking behavior in response to changes in site characteristics, and are used to estimate damages based in part on the incremental time costs and out-of-pocket costs that result. Multiple-site travel cost models consider how anglers will substitute their fishing trips to other sites. The regulations specifically identify the need to address substitutability of uses (or sites) for injured resource services [43 CFR § 11.84 (f)].

The recreation valuation study included several data collection efforts:

1. An in-field intercept survey of 1,951 anglers at 26 different river segments throughout southwestern Montana between May 1, 1992 and August 23, 1992. The 26 study sites included the injured sites (Silver Bow Creek and the upper Clark Fork River between Warm Springs Ponds and Milltown Dam broken down into five segments), and uninjured substitute sites. This survey provided data on catch rates and characteristics of visits to the sample sites.

2. A postcard survey conducted concurrently with the in-field intercept survey. Postcards were left on cars in the survey area. This survey provided data on fishing and nonfishing activity at the 26 sites. In total, 2,224 postcards were returned and provide data on 6,346 recreational visits to rivers and streams in southwestern Montana.

3. Follow-up telephone and mail surveys were conducted during the summer and fall of 1992 with a subset of anglers included in the intercept survey. These surveys were used to collect extensive data on the number of fishing trips and choice of sites during the summer season (May through September), attitudes and opinions about the study sites, and socioeconomic information. In total, 513 anglers participated in these follow-up survey activities.

Overall, the surveys provide data to estimate how changes in catch rates affect both the number of times anglers fish and the selection of fishing sites. The surveys also demonstrate the importance of catch rates to fishing. Overall, anglers state that the number and type of fish they expect to catch at a site are two of the most important determinants of where they go fishing. Trout are overwhelmingly the most sought-after species for cold water fishing at the rivers and streams in southwestern Montana. Furthermore, anglers' perceptions of catch rates at selected sites throughout southwestern Montana accurately reflect estimated catch rates. Therefore, we expect anglers to respond to changes in expected catch rates resulting from the cleanup of the Clark Fork River and Silver Bow Creek.

An analysis was conducted to estimate how catch rates at the impacted sites would improve if trout stocks were returned to baseline conditions. The average increase in expected catch rates under baseline conditions along the entire 145 river miles of Silver Bow Creek and the upper Clark Fork River between Butte and Milltown Dam would be about 1.05 additional fish caught during every four hours of fishing, or about a 109 percent increase. With this increase in expected catch rates, these sites would be among the best fishing sites in southwestern Montana.

The recreation demand model was used to estimate how catch rates and travel distances affect how often and where fishing trips are taken. This model was then used to determine the effects of changes in catch rates at the impacted sites under baseline conditions. The model estimates that the average Montana resident angler in the survey sample would take 1.2 additional trips each summer season to the impacted sites under baseline conditions. The same figure for nonresident anglers in the sample is 0.2 additional trips each summer season. Most of these additional trips to the impacted sites would be substituted away from other, less-preferred sites.

By comparison, the mail survey of anglers included a contingent behavior analysis that asked how anglers would change their fishing behavior if catch rates at a segment of the upper Clark Fork River were increased by one fish per every four hours of fishing. The result of about one more trip to the site every year is very similar to that from the recreation demand model. The recreation demand model estimates of increases in fishing trips to the impacted sites under baseline conditions is consistent with anglers' stated responses to the expected increase in catch rates.

The recreation demand model is also used to predict the economic value of the improvement in catch rates to baseline conditions. The model computes damages per angler in the survey sample of $75.28 per summer season for resident anglers and $13.25 for nonresident anglers (in 1992 dollars). For comparison to other studies, one can divide the annual damages per angler by the number of affected trips per angler, which we define as additional trips to the injured sites if the sites are returned to baseline conditions. These dollar-per-affected-trip values are about $63 (in 1993 dollars). These values are similar to or somewhat less than values reported in the literature for similar sites.

The results for sample anglers are generalized to the population of Montana fishing license holders who fish at rivers and streams in southwestern Montana by accounting for the number of license holders and average avidity, and by adjusting seasonal figures to reflect the entire year, to estimate the total change in site visits per year and annual fishing use damages. These results are summarized in Table 3. In total, nearly 42,000 additional fishing trips per year are predicted to occur at the impacted sites under baseline conditions, and most of these trips would be taken by Montana residents. This amounts to an increase of about 130 percent. Annual fishing damages are estimated to be over $2.6 million (in 1993 dollars), the majority of which is incurred by Montana residents.

Nonfishing Recreation Damages

Nonfishing recreation along rivers and streams includes activities such as resting and relaxing, walking or hiking, observing wildlife, camping, boating, hunting, and other activities. Just as the release of hazardous substances results in natural resource injuries

Table 3
Summary of Recreation Valuation Study Results
($ 1993)

Impact Measure	Population	Fishing Recreation	Nonfishing Recreation	Total
Additional trips annually to the Clark Fork River and Silver Bow Creek under baseline conditions	Montana residents	36,700	NA	NA
	Nonresidents	5,100	NA	NA
	Total	41,800	21,500	63,300
Damages per affected trip	Montana residents	$63	$37	–
	Nonresidents	$64	$38	–
Total annual use damages	Montana residents	$2,297,000	NA	NA
	Nonresidents	$ 330,000	NA	NA
	Total	$2,627,000	$ 811,000	$3,438,000

Notes: Includes only recreation damages along the upper Clark Fork River and Silver Bow Creek. Trips rounded to nearest 100. Damages per affected trip rounded to nearest dollar. Total damages rounded to nearest $1,000.
1992 dollars are adjusted to 1993 dollars assuming an annual inflation rate of 2.79 percent based on the inflation rate from January through October 1993 as reported by the U.S. Department of Labor, Bureau of Labor Statistics.
Values may not add exactly because of rounding.
NA = Not available.
Source: Morey *et al.*, 1993.

that affect the fishing experience, so also do many of the same injuries affect the quality and quantity of nonfishing recreation. For example, streamside tailings that affect the fishery also reduce vegetation and the desirability of a site for nonfishing recreation.

Data from the postcard survey described above and data from the literature are used to estimate nonfishing damages, which are summarized in Table 3. We estimate that for every 100 additional fishing visits to the impacted sites during the summer season, there will be 55 additional nonfishing recreation visits, about half of which will be by individuals who accompany anglers on fishing trips. After adjusting for annual (as compared to seasonal) use, we estimate a total of approximately 21,500 additional nonfishing recreation fishing trips to the impacted sites each year if the sites are returned to baseline conditions, or an increase of about 48 percent. Based on published literature, nonfishing recreation trips are valued at about 60 percent of fishing trips. Therefore we apply a unit value of approximately $38 ($63 per affected trip in the fishing study times 0.6) to each additional nonfishing trip. The use of unit values from the literature is a recognized approach to assign damages to recreational impacts [43 CFR § 11.83 (d)(6) and Proposed 43 CFR § 11.83 (c)(2)(ii)(E)].

Total Recreation Damages

In total, an increase of approximately 63,300 fishing and nonfishing recreation trips is predicted to occur each year under baseline conditions. The total annual recreation damages in 1992 are $3.44 million (in 1993 dollars).[2] These annual recreation use damages are used below to compute past, interim, and residual use damages for injuries to the aquatic resources and riparian habitat resource group.

2.2.3 The Contingent Valuation Study

A contingent valuation method (CVM) survey was designed and implemented to estimate total compensable damages, including use values and nonuse values held by Montana residents, for partial and complete cleanup of natural resource injuries in the upper Clark Fork River Basin (Schulze *et al.*, 1993). The study does not estimate compensable damages incurred by nonresidents of Montana.

According to the DOI regulations for natural resource damage assessments, "The contingent valuation methodology includes all techniques that set up hypothetical markets to elicit an individuals's economic valuation of a natural resource" [43 CFR § 11.83 (d)(5)(i)]. CVM is recognized as a "best available procedure" for estimating compensable damages.

The CVM has undergone Federal Court review (U.S. Court of Appeals, District of Columbia Circuit, 1989). The Court rejected a challenge to the DOI's use of CVM in calculating damages. The court stated, "We find DOI's promulgation of CV methodology reasonable and consistent with Congressional intent, and therefore worthy of deference," and "We find no cause to overturn DOI's considered judgment that CV methodology, when properly applied, can be structured so as to eliminate undue upward bias." The same Court decision also ruled that nonuse values are appropriate in damage assessments. Since CVM is the only method currently acknowledged by DOI to estimate nonuse values, application of the CV method is required.

More recently, the National Oceanic and Atmospheric Administration (NOAA) commissioned a "Blue Ribbon Panel on Contingent Valuation," which also concluded that CV provides reliable measures of nonuse values as long as a CVM study generally follows several recommendations.

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[2] 1992 dollars are adjusted to 1993 dollars assuming an annual inflation rate of 2.79 percent based on the inflation rate from January through October 1993 as reported by the U.S. Department of Labor, Bureau of Labor Statistics.

> We think it is fair to describe such information *(CVM results)* as reliable by the standard that seems to be implicit in similar contexts, like market analysis for new and innovative products and assessment of other damages normally allowed in court proceedings. As in all such cases, the more closely the guidelines *(for conducting a CVM study)* are followed, the more reliable the results will be. It is not necessary, however, that every single injunction be completely obeyed; inferences accepted in other contexts are not perfect either. (NOAA, 1993, page 41). (Text in italics is added for clarity.)

The Clark Fork River CVM study is a state-of-the-art application that is consistent with the NOAA panel's guidelines. Where the survey differs from the specific injunctions of the NOAA panel, the study uses equally reliable approaches for this application. The CVM survey provided respondents with information on Superfund NPL sites throughout Montana, detailed information on the natural resource injuries at the Clark Fork NPL sites, and information on cleanup options for the Clark Fork sites. Through a structured procedure, respondents were then asked for their willingness to pay for programs to completely or partially return the injured natural resources and service flows at the Clark Fork NPL sites to baseline conditions.

The CVM was conducted with a random sample of Montana households selected from telephone listings (telephone listings include 83 percent of all households in Montana). The study was completed by 933 individuals, 845 by mail and 88 by telephone. The mail response rate equals 68 percent of all households in the sample, after omitting deceased individuals and bad addresses. Virtually all of the returned surveys have all questions answered.

Most Montana residents are familiar with the Clark Fork NPL sites and feel that cleaning up these sites is important. Most respondents have seen, heard about, or read about the Clark Fork NPL sites: 84 percent for the Anaconda Smelter site, 70 percent for the Silver Bow Creek/Butte Area site, 58 percent for the Milltown Reservoir/Clark Fork River site, and 34 percent for the Montana Pole site. Respondents feel that cleaning up hazardous waste sites in Montana is very important, and that the Clark Fork NPL sites are the most important sites to clean up.

Respondents also feel that cleanup is very important for all three natural resource groups considered: aquatic resources and riparian habitat; groundwater; and upland soils, vegetation, wildlife, and wildlife habitat. Respondents rated bequest and existence value motives as more important than use value motives for cleaning up the sites.

The values measured in the CVM study for partial cleanup correspond to Areas A+B in Figure 1, but for a 10-year cleanup period rather than the 20 years used in this analysis. The values measured in the CVM study for complete cleanup correspond to Areas

A+B+C+D in Figure 1, again for a 10-year cleanup. The difference between the partial and complete cleanup values correspond to Areas C+D in Figure 1 for a 10-year cleanup.

The CVM results can be used to measure a total present value, including use and nonuse values, for partial cleanup and complete cleanup of the Clark Fork NPL sites. The total present value of damages is divided into values for aquatic resources and riparian habitat; groundwater resources; and upland soil, vegetation, wildlife, and wildlife habitat as listed in Table 4. The equivalent annual use and nonuse values are computed in Appendix A and amount to $10.4 million in use plus nonuse damages each year if no additional cleanup actions are undertaken.

The CVM study concludes that the results provide a conservative damage estimate because nonresidents are omitted, because Montana residents partially reject the responsibility to pay for cleanup (which decreases reported values as compared to the actual values the study attempts to measure), and because of conservative data analysis procedures.

2.2.4 Correspondence Between the Recreation Valuation and Contingent Valuation Studies

The recreation valuation study and the contingent valuation study overlap in measuring use damages to Montana residents for injuries to aquatic resources and riparian habitat. For complete cleanup, the recreation study results in a 1993 annual use value estimate for aquatic resource recreation for residents of $3.01 million. The CVM study results in a 1993 annual total use plus nonuse value for aquatic resource recreation of $3.70 million (Table A-1), which is 23 percent larger than for the recreation study. The annual aquatic resource value from the CVM study is expected to exceed that from the recreation study because the CVM study includes nonuse values that are not measured in the recreation study. If the CVM were capturing all of the total value, these results indicate that recreation use values are at least 81 percent of the total values measured in the CVM for aquatic resources and riparian habitat injuries. However, we conclude that because of downward biases in the CVM study, the total aquatic resource and riparian habitat damages are likely to be understated in the CVM study (this is also likely to be true for the other resource groups).

In the determination of compensable damages, we use the recreation study results to estimate aquatic resource and riparian habitat use damages. This is because we have recreation use damages for both residents and nonresidents, because use of the recreation valuation study results does not require an assumption about the use versus nonuse split of aquatic resource and riparian habitat damage estimates in the CVM study, and because we believe the CVM estimate understates damages.

Table 4
Summary of CVM Study Results for Montana Residents
(millions of $ 1993, present value in 1993 for a 10-year cleanup period)

Resource Group	Complete Cleanup (Areas A+B+C+D)	Partial Cleanup (Areas A+B)	Difference Between Complete and Partial Cleanup (Areas C+D)
Total of all resource groups	$120.2	$88.2	$32.0
Aquatic resources and riparian habitat	$42.7	$31.3	$11.4
Groundwater resources	$40.2	$29.5	$10.7
Upland soils, vegetation, wildlife, and wildlife habitat	$37.4	$27.4	$10.0

Source: Schulze *et al.*, 1993.

3.0 DETERMINATION OF COMPENSABLE DAMAGES

In this section we provide estimates of past, interim, and residual compensable damages for complete and partial cleanup, and if no additional cleanup is undertaken. The details of the calculations are provided in Appendix A. Past damages are computed for 1981 through 1993. Interim and residual damages are for cleanups that partially or completely return natural resources and their service flows to baseline conditions over a 20-year period, as illustrated in Figure 1. For aquatic resources and riparian habitat, we split recreation use from other use and nonuse values to specifically address the overlap between the CVM and recreation studies. For the groundwater and upland resource groups, we split the total CVM results into use and nonuse values to reduce nonuse values based on the assumption that additional cleanup will reduce past and interim nonuse damages (see Sections 2.1.1 and A.1). Based on literature values, we estimate that 35 percent of total WTP in the CVM is tied to use values and 65 percent to nonuse values. These splits are reported in Section A.2.

For each damage estimate, the reported measures understate actual damages because of conservative assumptions or omissions in the calculations.

3.1 PAST DAMAGES

Estimates of past damages are summarized in Table 5. Past aquatic resource and riparian habitat recreation use damages are based on the recreation study (Morey *et al.*, 1993) and include fishing and nonfishing recreation damages along the Clark Fork River and Silver Bow Creek. Past use damages are computed as 21.55 (in 1993 dollars, see Appendix Section A.1, Calculation 6) times the annual damages in 1993 of $3.44 million, which equals $74.09 million; these damages are assigned to Montana residents and nonresidents in proportion to annual fishing damages.

For aquatic resources and riparian habitat, we take the difference between the CVM study annual damages for this resource group and the recreation study annual damages ($3.70 - $3.01 = $0.69) to compute the annual damages for other use and nonuse values. This annual value of $0.69 is then multiplied by 18.19 (see Appendix Section A.1, Calculation 7), which equals $12.6 million.

We use the CVM results to compute past damage estimates for groundwater resources and for upland soils, vegetation, wildlife, and wildlife habitat. The annual average use value for each resource is multiplied by 21.55 (Section A.1, Calculation 6), and the annual nonuse value for each resource group is multiplied by 18.19 (Section A.1, Calculation 7).

Table 5
Past Damages 1981-1993
(millions of $ 1993, present value in 1994)

Resource Group	**Population Group**	**Value Category**	**Damages**
Aquatic resources and riparian habitat	Residents	Recreation use	$64.8*
		Other use and nonuse	$12.6***
	Nonresidents	Recreation use	$9.3*
		Other use and nonuse	Not quantified
	TOTAL	All quantified	$86.7
Groundwater	Residents	Use and nonuse	$67.5**
	Nonresidents	Use and nonuse	Not quantified
	TOTAL	All quantified	$67.5
Upland soils, vegetation, wildlife, and wildlife habitat	Residents	Use and nonuse	$62.8**
	Nonresidents	Use and nonuse	Not quantified
	TOTAL	All quantified	$62.8
TOTAL MEASURED	Resident	Use and nonuse	$207.6
	Nonresidents	Use and nonuse	$9.3
	TOTAL	All quantified	$216.9

* Derived from the recreation valuation study (Morey *et al.*, 1993).
** Derived from the contingent valuation study (Schulze *et al.*, 1993).
*** Derived from the difference of use values in the recreation study and total values in the contingent valuation study.

In total, past damages for 1981 through 1993 are estimated to be $216.9 million. More than one-third of these damages is related to use value recreation damages at the Clark Fork River and Silver Bow Creek.

Missing from the estimate of past damages are all nonresident use and nonuse damages, with the exception of aquatic-based recreation use values for nonresidents.

3.2 INTERIM DAMAGES WHILE COMPLETE CLEANUP IS UNDERTAKEN

Interim damages while complete cleanup is undertaken are computed in an analogous manner as for past damages (Area E in Figure 1). Annualized 1993 use damages are multiplied by a factor of 5.67 (Section A.1, Calculation 3), and annual nonuse damages are multiplied by 3.08 (Section A.1, Calculation 8). Specifically:

- The recreation study damage estimates are used to compute aquatic resource and riparian habitat recreation use damages for residents and nonresidents.
- For aquatic resources, the difference between the annual value in the CVM study and in the recreation study ($0.69 million) is assigned to "other use and nonuse" damages.
- The CVM study results are used to compute use and nonuse values for Montana residents for groundwater resources and for upland soils, vegetation, wildlife, and wildlife habitat.

Interim damages are summarized in Table 6 for a 20-year complete cleanup. In this event there are no residual damages. Total measured damages equal $48.4 million.

These estimates are conservative because of certain omissions including any and all nonuse damages to nonresidents, and the omission of nonresident use damages for groundwater and for soils, vegetation, wildlife, and wildlife habitat resources. Further, to the degree that the CVM results are biased downward, measured damages will also be biased downward.

3.3 INTERIM AND RESIDUAL DAMAGES WITH PARTIAL CLEANUP

If partial cleanup is undertaken, both interim and residual damages occur. These damages are computed using the same approach as above. Annualized 1993 use damages are multiplied by a factor of 8.27 (Section A.1, Calculations 3 and 5) to compute the present value of interim plus residual damages (Areas C+D+E). Annual

Table 6
Interim Damages if Complete Cleanup is Achieved During 1994-2013
(millions of $ 1993, present value in 1994)

Resource Group	Population Group	Value Category	Damages
Aquatics resources and riparian habitat	Residents	Recreation use	$17.0*
		Other use and nonuse	$2.1***
	Nonresidents	Recreation use	$2.4*
		Other use and nonuse	Not quantified
	TOTAL	All quantified	$21.6
Groundwater	Residents	Use and Nonuse	$13.9**
	Nonresidents	Use and nonuse	Not quantified
	TOTAL	All quantified	$13.9
Upland soils, vegetation, wildlife, and wildlife habitat	Residents	Use and Nonuse	$12.9**
	Nonresidents	Use and nonuse	Not quantified
	TOTAL	All quantified	$12.9
TOTAL MEASURED	Resident	Use and Nonuse	$46.0
	Nonresidents	Use and Nonuse	$2.4
	TOTAL	All quantified	$48.4

* Derived from the recreation valuation study (Morey *et al.*, 1993).
** Derived from the contingent valuation study (Schulze *et al.*, 1993).
*** Derived from the difference of use values in the recreation study and total values in the contingent valuation study.

nonuse values are multiplied by a factor of 6.38 (Section A.1, Calculation 8), reflecting that a share of the injuries continue forever and a share of the injuries are cleaned up over a 20-year period. These damages are summarized in Table 7. Total measured damages are over $80 million. These damages are over 65 percent larger than for interim damages with complete cleanup, which results from the increased level of interim damages plus residual damages that continue indefinitely.

These estimates are conservative because of certain omissions including any and all nonuse values held by nonresidents, and the omission of nonresident use damages for groundwater and for upland soils, vegetation, wildlife, and wildlife habitat resources. Further, to the degree that the CVM results are biased downward, measured damages will also be biased downward.

3.4 RESIDUAL DAMAGES IF NO ADDITIONAL CLEANUP IS UNDERTAKEN

Residual damages if no additional cleanup is undertaken are computed using the same approach as above. Annualized 1993 damages are multiplied by a factor of 15.29 (Areas A+B+C+D+E; see Section A.1). Measured damages are listed in Table 8 and are over $165 million. These damages are slightly more than twice the interim plus residual damages for partial cleanup. This is because the interim damages occur in the near future and are discounted less heavily than are the unremediated damages (Area B in Figure 1).

These estimates are conservative because of certain omissions including any and all nonuse values held by nonresidents, and the omission of nonresident use damages for groundwater and for upland soils, vegetation, wildlife, and wildlife habitat resources. Further, to the degree that the CVM results are biased downward, measured damages will also be biased downward.

3.5 DAMAGE DETERMINATION FOR DIFFERENT TIME PERIODS OF PAST DAMAGES AND FUTURE CLEANUP

Three important assumptions used in these calculations are that (1) damages will be paid in 1994 and additional cleanup activities will start in 1994; (2) past damages are only computed back to 1981; and (3) additional restoration will linearly reduce damages over a 20-year time horizon. If past damages go unpaid until 1996, then two years of interest are added. For past damages from 1981 through 1993, this adds over $31 million in additional interest at the OMB real rate of 7 percent. As more years are added to the past damages, damages increase at an increasing rate. For example, adding another 10 years to past damages (back to 1971) increases past damages by a factor of 2.653. If

Table 7
Interim Plus Residual Damages if Partial Cleanup is Achieved During 1994-2013
(millions of $ 1993, present value in 1994)

Resource Group	Population Group	Value Category	Damages
Aquatic resources and riparian habitat	Residents	Recreation use	$24.8*
		Other use and nonuse	$4.4***
	Nonresidents	Recreation use	$3.6*
		Other use and nonuse	Not quantified
	TOTAL	All quantified	$32.8
Groundwater	Residents	Use and nonuse	$24.5**
	Nonresidents	Use and nonuse	Not quantified
	TOTAL	All quantified	$24.5
Upland soils, vegetation, wildlife, and wildlife habitat	Residents	Use and nonuse	$22.8**
	Nonresidents	Use and nonuse	Not quantified
	TOTAL	All quantified	$22.8
TOTAL MEASURED	Resident	Use and nonuse	$76.6
	Nonresidents	Use and nonuse	$3.6
	TOTAL	All quantified	$80.2

* Derived from the recreation valuation study (Morey *et al.*, 1993).
** Derived from the contingent valuation study (Schulze *et al.*, 1993).
*** Derived from the difference of use values in the recreation study and total values in the contingent valuation study.

Table 8
Residual Damages if No Additional Cleanup is Undertaken
(millions of $ 1993, present value in 1994)

Resource Group	Resident Group	Value Category	Damages
Aquatic resources and riparian habitat	Residents	Recreation use	$45.9*
		Other use and nonuse	$10.6***
	Nonresidents	Recreation use	$6.6*
		Other use and nonuse	Not quantified
	TOTAL	All quantified	$63.1
Groundwater	Residents	Use and nonuse	$53.2**
	Nonresidents	Use and nonuse	Not quantified
	TOTAL	All quantified	$53.3
Upland soils, vegetation, wildlife, and wildlife habitat	Residents	Use and nonuse	$49.5**
	Nonresidents	Use and nonuse	Not quantified
	TOTAL	All quantified	$49.6
TOTAL MEASURED	Resident	Use and nonuse	$159.3
	Nonresidents	Use and nonuse	$6.6
	TOTAL	All quantified	$165.9

* Derived from the recreation valuation study (Morey *et al.*, 1993).

** Derived from the contingent valuation study (Schulze *et al.*, 1993).

*** Derived from the difference of use values in the recreation study and total values in the contingent valuation study.

additional cleanup programs are not initiated for two additional years, then two additional years of past damages are added, and the present value of interim and residual damages increases as well.

The rate of cleanup affects the calculation of interim and residual damages. If cleanup reduces damages at a slower rate, interim and residual damages will increase, and vice versa. For example, compared to a complete cleanup effort that takes 20 years, the present value of interim damages for a similar effort in 15 years is about 15 percent less, and the present value of interim damages for a similar effort in 25 years is about 10 percent greater. For partial cleanup, increasing or decreasing the rate of cleanup by five years changes damages by less than 7 percent.

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APPENDIX A

Detailed Calculations

A.1 CALCULATION OF DAMAGES REPRESENTED BY AREAS A-E AND AREA Z IN FIGURE 1

The damages represented by areas A through E are computed as a multiple of the annual damages if no remediation occurs, \$D, and by calculating present values to 1994. Calculations are presented for cleanup activities over a 20-year period. The same types of calculations can be applied for alternative cleanup periods such as 15 or 25 years.

Calculations 1 through 6 below apply to use damages. Calculations 7 and 8 are for nonuse damages.

The damage calculations are based on injuries and populations as of 1993. In the past, damages may have been slightly smaller because the population was slightly smaller. For example, in the recreation report we adjusted for the change in past fishing licenses between 1981 and 1993, which reduces past damages by about 3 percent. Similarly, adjusting interim and residual damages upward for population growth would increase future damages slightly. Because the change in population through time in Montana is small, we do not make any adjustments for past or future population changes. The net effect on estimated damages is very small.

Use Damages

1. Areas A+B+C+D+E = \$D × 15.286. This is the present value of the annual damages in perpetuity and is computed as \$D × (1+(1/0.07)). (There are undiscounted current year damages plus a perpetual stream of discounted future damages, and thus the term 1 is added into the expression.)

2. Areas A+C+E = \$D × 11.336. This is the present value of the annual unremediated damages. This is computed as $\$D \times \{1+ [(1 - (1.07)^{-(N-1)}) / (0.07)]\}$ where N is the number of years of the cleanup program. Therefore, Areas B+D = \$D × 3.950, which is Areas A+B+C+D+E (Calculation 1) minus Areas A+C+E (Calculation 2).

3. Area E equals Areas A+C = \$D × 5.668 (which equals 11.336 × 0.5). Area E is a triangle equal to half of the A+C+E rectangle. Area E is the unremediated interim damages given complete cleanup.

4. Areas A+B+C+D = \$D × 9.618. This is the value of damages avoided by complete cleanup, and is Areas A+B+C+D+E (Calculation 1) minus Area E (Calculation 3).

5. Areas A+B are 73 percent of Areas A+B+C+D and Areas C+D are 27 percent of Areas A+B+C+D for the 20-year cleanup. This is derived from the CVM results where the value of partial cleanup (Areas A+B) is 73 percent of the value of complete cleanup (Areas A+B+C+D) when completed over a 10-year period. As a result:

   Area A = $D × 4.138, or 73 percent of Areas A+C.
   Area B = $D × 2.884, or 73 percent of Areas B+D.
   Area C = $D × 1.530, or 27 percent of Areas A+C.
   Area D = $D × 1.067, or 27 percent of Areas B+D.

6. Area Z equals past damages and includes interest on past damages, computed as:

$$\begin{aligned} Z_{use} &= \sum_{i=1981}^{1993} \$D\ x\ [(1.07)^{(1994-i)}] \\ &= \$D\ x\ \{[(1.07)^{(1994-1980)}-1]/0.07\}-1 \end{aligned} \tag{A-1}$$

   For the period 1981 through 1993, this equals $D × 21.550.

Nonuse Damages

For nonuse damages, we make an additional correction to reflect the potential that additional cleanup may reduce current nonuse damages (see Section 2.1.1).

7. Past nonuse damages are a multiple of annual nonuse damages without remediation ($Dnu), calculated as:

$$Z_{nu} = \sum_{i=1981}^{1993} \$Dnu\ x\ \frac{1+[1-(1.07)^{(2014-(i+1))}]}{(1+1/1.07)}\ x\ (1.07)^{(1994-i)} \tag{A-2}$$

   For each past year (t=1981 through 1993), the present value in 1994 of nonuse damages is computed as the multiple of three terms:

   - The first term is the annual nonuse damages assuming no cleanup activities occur ($Dnu) and injuries continue into perpetuity.
   - The second term is the ratio of two streams of values. The numerator is the present value of a constant stream of injuries between the current year and 2014 (the year cleanup is assumed to be achieved) using the OMB real

discount rate. The denominator is the present value of a constant stream of injuries from the current year into perpetuity (e.g., no cleanup efforts are undertaken) using the OMB real discount rate. This ratio is used to reduce nonuse damages in each current year in proportion to the discounted present value of injuries up to completion of cleanup divided by the discounted present value of injuries in perpetuity. Implicit in this calculation is the assumption that resource injuries in near-term years have a greater impact on current bequest and existence damages now than do resource injuries in the distant future. This correction eliminates the assignment of nonuse damages to injuries that are mitigated in future years.

- The third term adds interest at 7 percent per year from the year of the nonuse damages to 1994, just as in Equation (A-1).

This calculation assumes there will be complete restoration of resources in 2014, and assumes restoration is certain and known to all affected individuals. These features bias the nonuse estimates downward because restoration is uncertain and because complete restoration may not be undertaken. Offsetting this, the calculation does not adjust for ongoing reductions in injuries during cleanup programs between 1994 and 2014, which results in overstated nonuse damages. The net effect is small because these biases are offsetting and are tied to injuries in the more distant future, which are more heavily discounted than are near-term injuries.

The present value of past damages from 1981 through 1993 equals \$Dnu × 18.19.

8. For interim damages during complete cleanup, Equation A-2 is applied in the same manner for t = 1994 through 2013, but with an added term of 1/2 multiplied times each annual value to recognize that ongoing cleanup reduces injuries by half during the interim period (Area E is half of Areas E+C+A). This amounts to nonuse damages of \$Dnu × 3.084.

   For interim and residual damages during and after partial cleanup, 27 percent of injuries continue indefinitely and have a present value of nonuse damages of \$Dnu × 15.286 × 0.27 = 4.127. The remaining 73 percent of injuries are remediated over 20 years, so we use 73 percent of the 3.084 factor, or \$Dnu × 0.73 × 3.084 = 2.251. The combined nonuse multiplier is therefore 6.378 (4.127 + 2.251).

A.2 CALCULATION OF ANNUAL DAMAGES FOR MONTANA RESIDENTS FROM THE CVM STUDY

Annual Total Values

The CVM study provides WTP estimates of the total of use plus nonuse values for complete cleanup and partial cleanup of the sites based on a payment occurring over 10 years. The present value of the complete cleanup is $120.2 million. The cleanup time period matters in a CVM study. The value one holds to clean up a site decreases the longer the cleanup takes. For example, a cleanup of a river taking ten years will have a lower value than the same cleanup taking one year because more years of use, bequest, and existence values would be lost with a ten-year cleanup than would be lost with a one-year cleanup. The WTP study estimates annual WTP over ten years to obtain complete cleanup and partial cleanup of the Clark Fork NPL sites.

The implicit cleanup time frame is generally assumed by respondents to match or exceed the payment period in the CVM survey (ten years), because funded activities may occur over ten years, but respondents recognize that the results may take longer to attain. We compute the equivalent annual damages as follows for three alternative assumptions about site cleanup:

1. Assuming the CVM values are for a gradual cleanup over 10 years, the complete cleanup values of $120.2 million correspond to Areas A+B+C+D in Figure 1 for a 10-year cleanup. Using Calculations 1 and 3 in Section A.1, but for a 10 year period, the present value factor is 11.528. Therefore, the annual value of current damages is $120.2/11.528, or $10.43 million.

2. Assuming the CVM values are for a sudden cleanup (the resources are suddenly available) after 10 years, then the $120.2 complete cleanup value would be interpreted as corresponding to Areas B+D in Figure 1 for a 10-year period. The 1993 annual value of damages is thus $120.2/7.77, or $15.47 million. This value is about 48 percent larger than when assuming a gradual cleanup over 10 years.

3. Assuming the CVM values are for a gradual cleanup over 20 years, the $120.2 million corresponds to Areas A+B+C+D in Figure 1. Using Calculations 1 and 3 in Section A.1, the annual value is $120.2/9.618 = $12.50 million, or 20 percent larger than assuming a gradual cleanup over 10 years.

In the analysis we use Assumption 1, which is the most conservative interpretation of the CVM results. Next, we compute the annual current damages for each resource group (reported in Table 5) using the same 11.528 factor as in Assumption 1. These values are reported in Table A-1.

Table A-1
Calculation of Annual Damages to Montana Residents from the CVM Survey
(millions of $ 1993, present value in 1994)

	Variable	Aquatic Resources And Riparian Habitat	Groundwater Resources	Upland Soils, Vegetation, Wildlife, and Wildlife Habitat
1.	Adjusted present value of complete cleanup (Table 4)	$42.7	$40.2	$37.4
2.	Annual value of complete cleanup (line 1/11.528)	$3.702	$3.485	$3.243
3.	Annual use values (assume 35 percent, except for aquatics use 81 percent based on recreation study)	$3.006	$1.220	$1.135
4.	Annual nonuse values (assume 65 percent, except for aquatics use 19 percent based on recreation study)	$0.692	$2.265	$2.108

Splits Between Use and Nonuse Values

Finally, where required, we allocate the CVM estimates to use and nonuse values to apply the additional correction factor to nonuse values to determine the present value of past and interim damages. It is important to recall that without the nonuse correction factor that accounts for future remediation, a split between use and nonuse values is not required. Further, given uncertainty about the amount and timing of cleanup, it may be appropriate to include nonuse damages without correcting for future cleanup.

The split of total CVM values between use and nonuse motives was not specifically estimated in the CVM survey, although the results reported in Table 4-7 of the CVM report (Schulze *et al.,* 1993) suggest that, across all resource groups, nonuse motives are more important than use value motives. For aquatic resources, we use the use value estimates from the recreation study because that study provides a direct estimate of use values for this resource group, which is 81 percent of the CVM total annual use and nonuse values. For the other two resource groups, based on similar CVM studies, we assume that 35 percent of the CVM estimate is for use, and the remainder is for nonuse. The resulting annual use and nonuse values by resource group are reported in Table A-1.

It is important to note that the split of total values between use and nonuse motives has no impact on residual damage estimates after partial cleanup. Further, the split of total values between use and nonuse motives has a very small impact on past damages. For example, for past damages, the multiplication factor for annual use values is 21.55 (Section A.1, Calculation 6), and for annual nonuse values is 18.19 (Section A.1, Calculation 7). If the split of total values to use motives were 20 percent higher or lower (15 percent or 55 percent), total past use plus nonuse damages would change by less than 3 percent (only the groundwater and upland resource calculations are affected by this assumption).

The split of total damages between use and nonuse damages may affect interim damages more significantly, but again only for groundwater and upland resources (the split for aquatic resources is based on the recreation use study). For interim damages, the annual use value multiplier is 5.668 (Section A.1, Calculation 3), and the annual nonuse multiplier is 3.08 (Section A.1, Calculation 8). If the split of total values to use motives were 20 percent higher or lower (15 percent or 55 percent), total past use plus nonuse damages would change by less than 10 percent. Overall, assigning CVM damages for groundwater and upland resources to use and nonuse motives has a relatively small impact on the analysis as compared to other conservative assumptions made in the damage determination.